THEME	Revolutionize Aviation
LEVEL I	Vehicle Systems
LEVEL II	Propulsion and Power
Level III	**Aeropropulsion and Power (A&P) URETI**

OBJECTIVE

The objectives of the Aeropropulsion and Power (A&P) URETI Project are 1) to develop revolutionary aeropropulsion and power technologies and design methods, in a systems-oriented integration environment, 2) to enable NASA and industry to close technology gaps that prevent deployment of high performance, intelligent, safe and environmentally compatible systems, and 3) to implement the integrated and multidisciplinary education programs that will prepare students graduates and NASA/industry engineers to develop the revolutionary engine systems that will be needed to ensure pre-eminence of the U.S. aerospace industry.

KEY DELIVERABLES

Task 2.1	(3) Provide lifing/reliability/material analysis integration effort with virtual propulsion design environment	Aug-07
	(4) Provide variable fidelity component map generation capability; intelligent controls (planning only)	Jun-07
	(7) Provide aeroelastic response capability	Aug-07
	(8) Provide propulsion technology assessment of an airship configuration	Feb-04
	(9) Provide propulsion technology assessment of a HALE configuration	Sep-04
	(10) Final results for subsonic distributed/embedded propulsion technology study	Sep-05
	(11) Final results for supersonic distributed/embedded propulsion technology study	Sep-05
Task 2.2	(13) Provide FEM TBC model with damage propagation, including analysis results; performance results (database), preferred structure and processing methods for high temperature materials (intermetallic and co-continuous composites)	Mar-07
	(14) Provide the 1st gen combustion-driven fluidic actuator and plasma-based combustion augmentor, including physics-based design models	Mar-05
	(15) Provide perform. results & optimized actuators for application to jet (nozzle) noise reduct., combustor mixing & flame stab.	Jun-07
	(16) Demonstration of high temperature, passive wireless MEMS sensor for temp and chemical sensing using existing materials	Mar-05
	(17) Demonstration of high T, passive, wireless MEMS sensor for temperature and chemical sensing using novel materials; integration results of sensor in engine-simulation environment; databases of turbulence impact on vane/blade heat transfer for fully cooled turbine stage, and hot streak migration in hp tubine (for incorporation into turbine design tools)	Jul-07
	(19) Provide combustion characterization of nanoadditives for fuel gels	Aug-05
	(20) Provide nanobelt sensor, including design/fabrication methodologies; product characterization of nanofuel gels	Sep-07
Task 2.3	(22) Provide assessment of integrated actived compressor/combustor control approach	Sep-07
	(23) Report on preliminary active emissions control system	Sep-05
	(24) Provide control system architectures and approaches for reducing emissions and improving pattern factor without compromising engine safety	Sep-07
	(25) Report on Loss Control Using Trailing Edge Injection - Understanding of the effect of gas injection through turbine blades edges upon flow losses, and approaches for using such gas injection to improve engine performance.	Sep-07
	(26) Provide Advanced Film Cooling Techniques - Data that can be used to guide the design of active blade cooling approaches.	May-05
	(27) Provide Active Noise Control - Data on open loop control of jet noise using combustion based actuation	Sep-05
	(28) Provide Active Noise Control - Combustion driven actuator suitable for active jet noise control and approaches for their use in open and/or closed loop jet noise control.	Sep-07
Task 2.4	(30) Documentation of all acoustic results and a work plan for the remaining effort	Sep-04
	(31) Documentation of all fluid dynamics and thrust results and correlation with the acoustic performance	Sep-05
	(33) Final Report describing the results of the distributed exhaust nozzle study	Sep-07
	(35) Provide the completed analysis of the impact on performance and efficiency maps for existing NASA configurations (Rotor 67, Rotor 35)	Sep-05
	(37) Final Report describing an active control methodology to radially and temporally tailor the incidence angle of the flow for optimum performance of the rotor under off-design conditions.	Sep-07
	(40) Provide numerical and experimental determination of ranges of flameless combustion operating conditions	Sep-05
	(41) Final Report on Experimental and Numerical Studies and demonstration of Flameless Combustion	Sep-07
Task 2.5	(43) Provide conceptual design of all-electric aircraft incorporating fuel cells and superconducting motors.	Sep-05
	(45) Provide simulation of advanced architecture power system to assess impact of new techs (advantages, failure modes,	Sep-07
	(46) Demonstration of fuel-cell powered flight of small-scale remotely-piloted air vehicle.	Sep-07
	(47) Report on prototype completion or proof-of-principle tests of superconducting motor & fuel cells	Sep-07
Task 2.6	(49) 6 semester and 6 short courses developed (cumulative)	Aug-05
	(50) 10 semester and 10 short courses developed (cumulative)	Aug-07
	(52) 2 Educational Workshop hosted	Aug-07

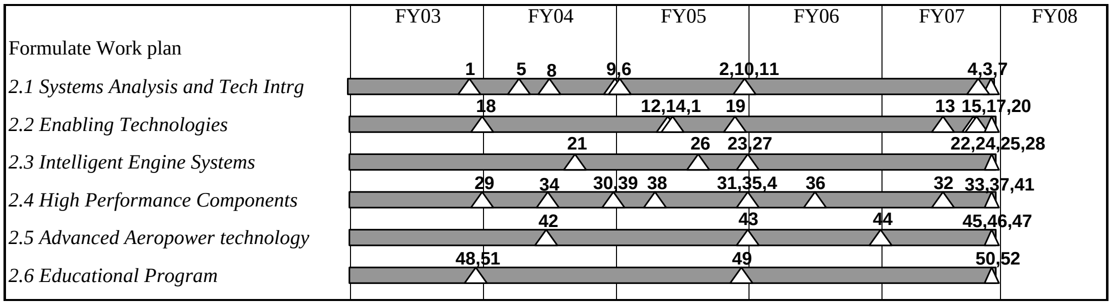
IMPACT

The project will develop a wide range of innovative propulsion and power technologies that will enable NASA/industry to produce systems that meet highly restrictive local environmental (emissions and noise) regulations, burn less fuel to reduce global warming, improve safety beyond current levels, and exhibit lower acquisition and operating costs. Developing these capabilities will enable NASA to attain its 10 and 25 year Aerospace Enterprise goals.

TECHNICAL APPROACH

The research portfolio consists of five major thrusts involving interdisciplinary teams from a team of four universities; The three major partners are the Georgia Institute of Technology (GT), Ohio State University (OSU), and Florida A&M University (FAMU), and a minor partner is the Case Western Reserve University (CWRU). The research areas include 1) system level engineering analysis and technology integration methods (e.g., creation of a virtual stochastic system and technology assessment environment, and formulation & development of physics based methods for analysis and design of Revolutionary Concepts, Architectures, and Technologies - RCAT), 2) enabling technologies that are applicable to a number of engine components and systems (e.g., advanced materials, MEMS and nanotechnology based devices, and fluidic actuators), 3) intelligence engine components and systems (e.g., active combustor emissions control, actively cooled turbine blades), 4) high performance components (e.g., highly loaded compressor blades, flameless combustors), and 5) advanced power technologies (e.g., light weight fuel cells, superconducting motors).
The benefits of the developed technologies of existing and new engine concepts will be evaluated and optimized using advanced design, system integration, and optimization approaches that incorporate uncertainty analysis. These results will subsequently be mapped against the Enterprise goals for a variety of conventional and revolutionary vehicle concepts.

SCHEDULE



MILESTONES

Task 2.1	(1) Delivery of baseline modeling and simulation environment to NASA GRC	Aug-03
	(2) Documentation of Preliminary results - set of requirements for new materials	Sep-05
	(3) Documentation on lifing/reliability/material analysis intgr w/ virtual propulsion design environ.	Aug-07
	(4) Demo of variable fidelity component map gen. capability; intelligent controls (planning only)	Jun-07
	(5) Summary of analysis based on additional measurements using TFE 731-2 rig	Dec-04
	(6) Deliver results of measurement program to NASA Glenn and to Georgia Tech.	Oct-05
	(7) Demonstration of aeroelastic response capability	Aug-07
	(8) Documentation of propulsion technology assessment of an airship configuration	Feb-04
	(9) Documentation of propulsion technology assessment of a HALE configuration	Sep-04
	(10) Documentation of final results for subsonic distributed/embedded propulsion technology study	Sep-05
	(11) Documentation of final results for supersonic distributed/embedded propulsion technology study	Sep-05
Task 2.2	(12) Finite element model (FEM) of TBCs; characterization of Nb-Ti-Si (refractory intermetallic composite) for near netshape application; determination and characterization of most promising co-continuous composites	Feb-05
	(13) FEM TBC model with damage propagation, including analysis results; performance results (database), preferred structure and processing methods for high temperature materials (intermetallic and co-continuous composites)	Aug-07
	(14) 1st gen combustion-driven fluidic actuator and plasma-based combustion augmentor, including physics-based design models	Mar-05
	(15) Perform. results & optimized actuators for application to jet (nozzle) noise reduct., combustor mixing & flame stab.	Jun-07
	(16) Demo of high temperature, passive wireless MEMS sensor for temp and chemical sensing using existing materials	Mar-05
	(17) Demo of high T, passive, wireless MEMS sensor for temperature and chemical sensing using novel materials; integration results of sensor in engine-simulation environment; databases of turbulence impact on vane/blade heat transfer for fully cooled turbine stage, and hot streak migration in hp tubine (for incorporation into turbine design tools)	Jul-07
	(18) Carbon nanotube flow sensor, including design and fabrication methodologies	Oct-04
	(19) Combustion characterization of nanoadditives for fuel gels	Aug-05
	(20) Nanobelt sensor, including design/fabrication methodologies; product characterization of nanofuel gels	Sep-07
Task 2.3	(21) Compressor Control - Algorithms for real time monitoring of compressor stability and framework for combined compressor and combusor control	May-04
	(22) Compressor Control -Assessment of integrated actived compressor/combustor control approach	Sep-07
	(23) Emissions Control - Preliminary active emissions control system	Sep-05
	(24) Emissions Control - Control system architectures and approaches for reducing emissions and improving pattern factor without compromising engine safety	Sep-07
	(25) Loss Control Using Trailing Edge Injection - Understanding of the effect of gas injection through turbine blades edges upon flow losses, and approaches for using such gas injection to improve engine performance.	Sep-07
	(26) Advanced Film Cooling Techniques - Data that can be used to guide the design of active blade cooling approaches.	May-05
	(27) Active Noise Control - Data on open loop control of jet noise using combustion based actuation	Sep-05
	(28) Active Noise Control - Combustion driven actuator suitable for active jet noise control and approaches for their use in open and/or closed loop jet noise control.	Sep-07
Task 2.4	(29) Preliminary results on noise reduction capabilities of distributed exhaust nozzles under flight simulation	Sep-03
	(30) Documentation of all acoustic results and a work plan for the remaining effort	Sep-04
	(31) Documentation of all fluid dynamics and thrust results and correlation with the acoustic performance	Sep-05
	(32) Empirical prediction code for distributed exhaust noise	Mar-07
	(33) Final Report describing the results of the distributed exhaust nozzle study	Sep-07
	(34) Results of analyses of a single stage rotor to model the effects of the Coanda jets on rotor aerodynamics	Mar-04

Task 2.4	(35) Completion of the analysis of the impact on performance and efficiency maps for existing NASA configurations (Rotor 67, Rotor 35)	Sep-05
	(36) Complete 3-D Analysis and Control Laws	Mar-06
	(37) Final Report describing an active control methodology to radially and temporally tailor the incidence angle of the flow for optimum performance of the rotor under off-design conditions.	Sep-07
	(38) Preliminary predictions of flameless combustion characteristics and flameless combustor design	Dec-04
	(39) Construction and checkout of flameless combustor setup	Sep-04
	(40) Numerical and experimental determination of ranges of flameless combustion operating conditions	Sep-05
	(41) Final report on experimental and numerical studies and demonstration of flameless combustion	Sep-07
Task 2.5	(42) System-level models for high power fuel cells, superconducting motors, and reconfigurable network architectures.	Jun-04
	(43) Conceptual design of all-electric aircraft incorporating fuel cells and superconducting motors.	Sep-05
	(44) Demonstration of a functionally graded fuel cell electrode	Sep-06
	(45) Simulation of advanced architecture power system to assess impact of new techs (advantages, failure modes, etc.)	Sep-07
	(46) Demonstration of fuel-cell powered flight of small-scale remotely-piloted air vehicle.	Sep-07
	(47) Prototype completion or proof-of-principle tests of superconducting motor & fuel cells	Sep-07
Task 2.6	(48) 2 semester and 2 short courses developed	Aug-03
	(49) 6 semester and 6 short courses developed (cumulative)	Aug-05
	(50) 10 semester and 10 short courses (cumulative)	Aug-07
	(51) Educational Workshop # 1	Sep-03
	(52) Educational Workshop # 2	Aug-07

UAPT MANAGEMENT

Dr. Jean Lou Chameau, GT's Provost, will be the UAPT's Senior Research Officer. Dr. Chameau will assure that the UAPT will get resources needed for optimal operation of its technical and educational programs. Drs. Ben T. Zinn and Dimitri Mavris, chaired professors at GT, will be the UAPT's Director and Co-Director, respectively. The management team will consists of Drs. Zinn, Mavris, Parekh, and the lead PI's at OSU (Dean Williams) and FAMU (Dr. Luongo). The UAPT management team will organize bi-annual program review meetings involving all the UAPT participants, and stay in touch with different activities via video-conferencing and regular meetings with individual investigators and groups, as wells forming both interdisciplinary & cross functional/cross university integrated product teams. The UAPT is organized into 6 categories of research, each task with its own lead. The systems analysis and technology integration task is lead by Dr. Mavris; the enabling technologies task is lead by Dr. Williams; the intelligent engine systems is lead by Dr. Zinn; the high performance components task is lead by Dr. Ahuja; the advanced power technology task is

RESOURCES

	FY03	FY04	FY05	FY06	FY07
NASA/DoD Funding ($K)	3100	3100	3000	3000	3000
Cost Sharing ($K)	965.902	951.910	959.687	967.824	976.336
Workforce (WY)	20.3	20.3	20.3	20.3	20.3

KEY FACILITIES

	FY03	FY04	FY05	FY06	FY07
GT: High Performance Computing					
GT: Combustion Laboratory					
GT/GTRI: Jet Facility					
GT: Microelectronic Research Center					
GT: Aerospace Propellant Lab					
OSU: Gas Turbine Laboratory					
OSU: SEM, TEM, Mech. Test equip., LENS, FIB					
OSU: Materials Synthesis & Microscopy Lab					
FAMU: Center for Advanced Power Systems					

AGREEMENTS

Partner	Agreement Title	Number
GT, OSU, FAMU, and CWRU	URETI for an integrated systems approach to revolutionary aeropropulsion and power technologies	NCC3-982
DoD	Memorandum of Agreement for Cooperation in URETI's	signed, 8/22/02
GRC ASAO, GRC Ceramics, GRC Compressor, GRC Turbine, GRC Controls, LaRC SAB	Verbal Collaborative Agreement	n/a

ACQUISITION STRATEGY

The primary acquisition instrument for this project was the NASA Cooperative Agreement Notice (CAN 01-OAT-01), an open and competitive procurement led by OAT. The GTI led team proposal was selected as the winner for the Aeropropulsion and Power URETI, and awarded the cooperation agreement (NCC3-982).

RISK MANAGEMENT

Risk	Mitigation Strategy
Cost Risk - costs growth from current estimations of $2.0M per year - due to increasing costs of institutions, facilities, human resources, inflation, and uncertainty of estimations.	1) Manage and monitor 2) Identify opportunities for resources optimization, leveraging, and new funding sources. Actionee: URETI Project Manager and URETI Management Team

Schedule Risk - facilities, expertise, tools, and/or funding not available at time needed.	1) Plan ahead for needs, 2) Manage, monitor, and communicate schedule changes. Actionee: URETI Management Team and Lead PIs.
Technical Risk - scientific and technologically unknowns and challenges in aeropropulsion and power research areas.	1) Accept, 2) Monitor, communicate, and manage technical challenges. Actionee: URETI Management Team and Lead PIs.

TECHNOLOGY TRANSFER

The results, computational models, design tools, prototypes, lesssons learnt, test data, and educational courses and workshops are all envisioned to be shared with NASA and all interested parties (with NASA approval). Furthermore, the educational aspects of this program will produce students who will serve as technology transfer conduits to government and industry.

EDUCATION OUTREACH

The Aeropropulsion and Power URETI will develop integrated, multidisciplinary, education programs to prepare future graduates, NASA engineers, and industry engineers to handle the challenges associated with the development of revolutionary propulsion systems via the following three-part approach:

1. Training of future engineers in advanced air-breathing propulsion at the undergraduate and graduate levels
2. Providing continuing education for government and industry engineers
3. Improving existing propulsion and power educational programs by involving government and industry personnel in teaching activities through classroom, seminar, and research participation, as well as providing opportunities for students to intern at NASA GRC and engine companies.

SIGNATURES

Ben T. Zinn
Ben T. Zinn
UAPT Director

Dimitri Mavris
Dimitri N. Mavris
UAPT Co-Director

Gary Seng 1/24/03
Gary Seng
Level II Manager

Kimlan Pham 1/24/03
Kimlan Pham
Level III Manager